**Unusual scales**

**Richter scale**

Scientists describe the magnitude (strength) of an earthquake using the Richter Scale.

This scale of numbers is unusual because an earthquake which measures 2 on the scale is not double the magnitude of an earthquake of measuring 1. It is 10 times the magnitude.

A close up of a logo

Description automatically generated

**Worked example**

How much greater is a magnitude 8 earthquake than a magnitude 6 one?

6 7 8

A magnitude 8 earthquake is 10 x 10 = 100 x greater than an earthquake of size 6.

**Practice questions**

1. How much greater is a magnitude 6 earthquake than an earthquake that has magnitude 3?
2. How much greater is a magnitude 7 earthquake than an earthquake that has magnitude 3?

**pH scale**

The pH scale works in two directions.

A close up of a logo

Description automatically generated

pH 1 is 10 times more acidic than pH 2. pH 14 is 10 times more alkaline than pH 13.

**Worked example**

How much less acidic is pH4 than pH 3?

pH 3 is ten times more acidic than pH 4 so pH is ten times less acidic than pH 3 (or a tenth as acidic).

**Practice questions**

1. How much more acidic is pH1 than pH 4?
2. How much more alkaline is pH 14 than pH 12?
3. How much less acidic is pH 6 than pH 5?
4. How much less alkaline is pH 9 than pH 11?

*Chemistry > Big idea CSU: Substances and properties > Topic CSU3: Acids and alkalis > Key concept CSU3.1: pH scale*

|  |
| --- |
| **Response activity** |
| **Unusual scales** |

**Overview**

|  |  |
| --- | --- |
| Learning objective: | Acidic and alkaline solutions may be compared using the pH scale. |
| Observable learning outcome: | Compare acidity or alkalinity using the pH scale. |
| Activity type: | Clarifying - worked example |
| Key words: | acid |

This activity can help develop students’ understanding by addressing the misunderstandings revealed by the following diagnostic question:

* Comparing pH

|  |  |
| --- | --- |
| **B** | **BRIDGING**  This activity explores ideas that are usually taught at age 14-16, to build a bridge to later stages of learning. |

**What does the research say?**

Sheppard (2006) lists three things that high school students do not generally understand about pH.

1. pH is a measure of concentration
2. pH is not a measure of strength
3. pH is a logarithmic and not a linear scale

Concentration of hydrogen ions, strong and weak acids and logarithmic scales are not generally introduced to younger (age 11 to 14) students.

However, it is not unlikely that simplified teaching to these students could reinforce these misunderstandings at a later stage.

In this key concept, the phrase ‘more acidic’ is deliberately used rather than ‘stronger acid’. This is more consistent with the idea of concentration and avoids mention of strength which may cause confusion when learning about strong and weak acids later (where a strong acid is an acid which disassociates completely in water).

It is likely, if not explicitly told otherwise, that students will assume that the pH scale is linear. There may be benefits in making clearer at an earlier stage that this is not correct. The pH scale could be explained without logarithms in terms of a multiplication factor of ten between pH numbers. For example, pH1 is ten times more acidic than pH2. pH 14 is ten times more alkaline than pH 13.

**Ways to use this activity**

Explain the Richter scale to the whole class and work through the example. Allow students to practice using the two questions provided.

Then explain how the pH scale is different (it works in two different directions) and again work through the example. Students may consolidate their understanding using the practice questions.

*Differentiation*

Some students may need support in working with the scale, but they should be encouraged to use the x10 arrows on the diagram to move from one pH to the other.

**Expected answers**

Richter scale

1. x 1000
2. x 100 000

pH scale

1. x1000
2. x100
3. 10 x less acidic (or 1/10 as acidic)
4. 100x less alkaline (or 1/100 as alkaline)

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: Helen Harden

**References**

Sheppard, K. (2006). High school students' understanding of titrations and related acid-base phenomena. *Chemistry Education Research and Practice,* 7(1)**,** 32-45.